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THE SCIENCE AND ART

OF

ARITHMETIC;

For the Use of Schools.

PART II. VULGAR FRACTIONS.
PART III. APPROXIMATE CALCULATIONS.

BY

A. SONNENSCHEIN

AND

H. A. NESBITT, M.A., Univ. Coll., London.

ANSWERS TO THE EXERCISES.

LONDON:

WHITTAKER AND Co.

1871.

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V.

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THE

SCIENCE AND ART OF ARITHMETIC,

For the Use of Schools.

Part I. INTEGRAL.

By A. SONNENSCHEIN and H. A. NESBITT, M.A., Univ. Coll., London.

Price 2*s.* 6*d.*

London: Whittaker & Co., Ave Maria Lane.

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"Mr. Sonnenschein is a pupil, and a thoroughly taught pupil, of Mr. De Morgan's, and it is scarcely necessary to say more in order to convince all who know Mr. De Morgan's works that there is nothing like half-digested work in this arithmetic. This first part of Mr. Sonnenschein's book is admirable of its kind, and better fitted for ordinary school use than Mr. De Morgan's *Arithmetic*, which is more suitable to students and teachers. Brevity and lucidity in the exposition of principle are its main characteristics as a scientific book; and great care in the explanation of simple practical rules for shortening or verifying calculations is its main characteristic in reference to the art of computation. It gives a clear proof of all the rules,—insisting on the exact meaning of the various operations and their interpretation,—and contains a remarkably good chapter on the general properties of numbers, so far as they can be explained to beginners who have only mastered the arithmetic of integers. It is hardly possible to speak too well of this little book, which we have examined very carefully."—*Spectator.*

"Forty years have elapsed since the appearance of Prof. De Morgan's 'Elements of Arithmetic,' at a time when perhaps few teachers, as they submitted the rules of the science to their pupils, cared to establish them upon reason and demonstration. The effect of this work was that a rational arithmetic began to be taught generally, and the mere committing of rules to memory took its due subordinate position in the course of instruction. Such a method of treatment will go far to develop and exercise the reasoning powers, and in the case of many pupils, there is hardly any other subject which can so well be made a groundwork for the exercise of the reasoning faculty. The book before us is avowedly drawn up in agreement with the principles of Mr. De Morgan's work, and the aim of the authors is to lead the student 'to the discovery of the several rules by some path such as an original discoverer might have travelled.' In this first part, which treats of Integral Arithmetic, we consider that they have carried out their principles successfully, and hope they will succeed as well with the remaining two parts, which are to embrace respectively Vulgar Fractions and Approximate Calculations. The rules enunciated are few and tersely given; there is a great store of illustration; elementary difficulties are *well stated* and honestly grappled with, and cleared up in a way that brings the

subject to the level of the capacities of junior students; at the same time advanced as well as young teachers may gather much that is useful from the book. A reader who has carefully gone through the work, can hardly fail to master the early details of the science; if he fail, it will not be the fault of the authors. The subjects treated of are numeration, modes of computation, the so-called first four rules, contracted operations, scales of notation, and properties of numbers. Under this last division we have much valuable matter grouped under the several heads of Divisibility of Numbers, Casting out Nines, Resolution into Prime Factors, Greatest Common Measure, and Least Common Multiple. Throughout and at the end of the work occur numerous examples, very varied, all of which are carefully arranged, and many fully worked out in two or more ways. With this short analysis of the contents, we heartily commend the work to teachers generally, assuming, of course, that they will regulate their use of it in proportion to the requirements of age and ability of their pupils. The work is neatly got up, and we have detected hardly any errata."—*Nature.*

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XLVIII.

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XLIX.

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L.

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LI.

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LII.

(1) £1226. 13*s.* 4*d.* (2) 36 men. (3) £11. 4*s.* (4) 5 days. (5) 30 pumps. (6) £318. 15*s.* (7) 8 horses. (8) $9\frac{2}{3}$ hrs. (9) 80 men. (10) £3. 15*s.* (11) £75. (12) £1350. (13) $57\frac{1}{27}$ cwt.

LIII.

(1) £1. 9*s.* 2*d.*, £2. 0*s.* 10*d.* (2) 4*s.* 8*d.*, 7*s.*, 9*s.* 4*d.* (3) 1*s.*, 2*s.*, 3*s.*, 4*s.*, 5*s.*, 6*s.* (4) £1050, £1350. (5) £9. 6*s.* $10\frac{4}{5}d.$ (6) £22. 9*s.* 7*d.*, £29. 7*s.* 11*d.* (7) £12, £13. 10*s.*, £15, £16. 10*s.* (8) £126. 5*s.*, £151. 10*s.*, £212. 2*s.* (9) $\frac{16}{27}$ lb. (10) $7\frac{47}{60}$. (11) $\frac{320}{887}$, $\frac{420}{887}$, $\frac{120}{887}$, $\frac{27}{887}$. (12) 230 oz. (13) $16\frac{34}{41}$ carats. (14) $263\frac{1}{4}$ lbs. (15) A £45. 9*s.* $1\frac{1}{11}d.$, B £56. 16*s.* $4\frac{4}{11}d.$, C £68. 3*s.* $7\frac{7}{11}d.$, D £79. 10*s.* $10\frac{10}{11}d.$ (16) A £389. 12*s.* $2\frac{38}{77}d.$, B £259. 14*s* $9\frac{51}{77}d.$, C £194. 16*s.* $1\frac{19}{77}d.$, D £155. 16*s.* $10\frac{46}{77}d.$ (17) A £5, B £7. 10*s.*, C £9, D £10. 2*s.* 6*d.* (18) A £2625, B £2100, C £1120, D £200.

PART III. APPROXIMATE CALCULATIONS.

I.

(1) Convergents, $1, \frac{5}{6}, \frac{6}{7}, \frac{11}{13}, \frac{17}{20}, \frac{181}{213}$; limits of error, $\frac{1}{6}, \frac{1}{42}, \frac{1}{91}, \frac{1}{260}, \frac{1}{4260}$. (2) Conv. $\frac{1}{2}, \frac{8}{17}, \frac{9}{19}, \frac{17}{36}, \frac{111}{235}$; lim. $\frac{1}{84}, \frac{1}{323}, \frac{1}{684}, \frac{1}{8460}$. (3) Conv. $\frac{1}{2}, \frac{2}{5}, \frac{5}{12}, \frac{67}{161}, \frac{139}{334}$; lim. $\frac{1}{10}, \frac{1}{60}, \frac{1}{1932}, \frac{1}{53774}$. (4) $1, \frac{1}{2}, \frac{2}{3}, \frac{3}{5}, \frac{5}{8}, \frac{18}{29}$. (5) $\frac{1}{3}, \frac{7}{22}, \frac{106}{333}, \frac{113}{355}$. (6) $1, \frac{4}{5}, \frac{5}{6}, \frac{9}{11}, \frac{14}{17}$. (7) $1, \frac{10}{11}, \frac{11}{12}$. (8) $\frac{1}{258}, \frac{1}{259}$. (9) $\frac{1}{147}$ of an inch.

II.

(1) $\frac{2}{10}$. (2) $\frac{4}{10}$. (3) $\frac{6}{10}$. (4) $\frac{8}{10}$. (5) $\frac{125}{1000}$. (6) $\frac{375}{1000}$. (7) $\frac{625}{1000}$. (8) $\frac{875}{1000}$. (9) $\frac{3125}{10000}$. (10) $\frac{65}{100}$. (11) $\frac{8}{100}$. (12) $\frac{425}{1000}$. (13) $\frac{265625}{1000000}$. (14) $\frac{9296875}{10000000}$. (15) $\frac{312}{1000}$.

III.

I. (1) $\frac{1}{10}$. (2) $\frac{1}{100}$. (3) $\frac{1}{1000}$. (4) $\frac{1}{1000000}$. (5) $1\frac{1}{10} = \frac{11}{10}$. (6) $1\frac{1}{100} = \frac{101}{100}$. (7) $\frac{1}{10} + \frac{1}{100} = \frac{11}{100}$. (8) $\frac{3}{10} + \frac{1}{100} = \frac{31}{100}$. (9) $\frac{3}{10} + \frac{1}{100} + \frac{5}{1000} = \frac{315}{1000}$. (10) $\frac{3}{100} + \frac{1}{1000} + \frac{5}{10000} = \frac{315}{10000}$. (11) $3 + \frac{1}{10} + \frac{5}{100} = 3\frac{15}{100} = \frac{315}{100}$. (12) $31\frac{5}{10} = \frac{315}{10}$. (13) $128 + \frac{5}{100} + \frac{3}{1000} = 128\frac{53}{1000} = \frac{128053}{1000}$. (14) $12 + \frac{8}{10} + \frac{5}{1000} + \frac{3}{10000} = 12\frac{8053}{10000} = \frac{128053}{10000}$. (15) $1280 + \frac{5}{10} + \frac{3}{100} = 1280\frac{53}{100} = \frac{128053}{100}$.

II. (1) $\frac{157}{200}$. (2) $\frac{3}{16}$. (3) $\frac{117}{160}$. (4) $\frac{193}{320}$. (5) $\frac{16}{125}$. (6) $6\frac{1}{32}$. (7) $603\frac{1}{8}$. (8) $\frac{11}{20}$. (9) $\frac{371}{1000}$. (10) $\frac{1}{6250}$. (11) $\frac{11}{20000}$. (12) $\frac{101}{200}$. (13) $5\frac{1}{20}$. (14) $8\frac{111}{125}$. (15) $\frac{91}{125}$.

IV.

(1) $33\frac{93}{160} = 33{\cdot}58125$. (2) $5566\frac{431}{1600} = 5566{\cdot}269375$. (3) $484\frac{27}{320} = 484{\cdot}084375$. (4) $64\frac{11}{16} = 64{\cdot}6875$. (5) $50\frac{41}{64} = 50{\cdot}640625$. (6) $36\frac{839}{3200} = 36{\cdot}2621875$.

V.

(1) $2\frac{31}{40} = 2{\cdot}775$. (2) $66\frac{109}{160} = 66{\cdot}68125$. (3) $16\frac{347}{400} = 16{\cdot}8675$. (4) $82\frac{512}{625} = 82{\cdot}8192$. (5) $44\frac{41}{80} = 44{\cdot}5125$. (6) $4\frac{111}{256} = 4{\cdot}34375$. (7) $7\frac{147}{160} = 7{\cdot}91875$. (8) $\frac{621}{1600} = {\cdot}388125$.

VI.

(1) $42\frac{4}{5} = 42{\cdot}8$, 428, 4280, 42800. (2) $565\frac{15}{16} = 565{\cdot}9375$, $5659\frac{3}{8} = 5659{\cdot}375$, $56593\frac{3}{4} = 56593{\cdot}75$, $565937\frac{1}{2} = 565937{\cdot}5$. (3) $86\frac{7}{8} = 86{\cdot}875$, $868\frac{3}{4} = 868{\cdot}75$, $8687\frac{1}{2} = 8687{\cdot}5$. (4) $2\frac{31}{256} = 2{\cdot}96875$, $29\frac{11}{16} = 29{\cdot}6875$, $296\frac{7}{8} = 296{\cdot}875$, 2968750.

VII.

(1) $304\frac{39}{50} = 304{\cdot}78$, $3047\frac{4}{5} = 3047{\cdot}8$, $3\frac{239}{50000} = 3{\cdot}0478$, $30\frac{239}{5000} = 30{\cdot}478$. (2) $142\frac{7}{8} = 142{\cdot}875$, $333\frac{3}{8} = 333{\cdot}375$, $1762\frac{1}{8} = 1762{\cdot}125$, $190\frac{1}{2} = 190{\cdot}5$, $285\frac{3}{4} = 285{\cdot}75$, 381, $2190\frac{3}{4} = 2190{\cdot}75$, $22288\frac{1}{2} = 22288{\cdot}5$. (3) $3102\frac{321}{512} = 3102{\cdot}626953125$, $39\frac{3}{8} = 39{\cdot}375$. (4) 1506888, 64·71, ·009. (5) 34713·6, 3712.

VIII.

(1) 68·4714. (2) 68·4714. (3) 68·4714. (4) 6·84714. (5) ·12, ·00012, ·03, ·003, ·000003, ·0002, ·0002. (6) ·0121, ·010201, ·00008, ·0001, 84. (7) 235·95993, 2·3595993, ·023595993. (8) 86·4, 86·4, ·00864. (9) $6\frac{15}{16} = 6{\cdot}9375$, $1\frac{37}{80} = 1{\cdot}4625$, $\frac{13}{1600} = {\cdot}008125$. (10) $\frac{107}{125} = {\cdot}856$, $1\frac{71}{250} = 1{\cdot}284$, $1\frac{89}{125} = 1{\cdot}712$, $2\frac{7}{50} = 2{\cdot}14$, $2\frac{71}{125} = 2{\cdot}568$, $\frac{428}{625} = {\cdot}6848$. (11) $\frac{107}{1250} = {\cdot}0856$, $\frac{321}{2500} = {\cdot}1284$, $\frac{107}{625} = {\cdot}1712$, $\frac{107}{800} = {\cdot}214$, $\frac{428}{3125} = {\cdot}13696$, $1\frac{3657}{12500} = 1{\cdot}29256$, $13\frac{87}{125} = 13{\cdot}696$, $\frac{107}{78125} = {\cdot}0013696$.

IX.

(1) $3\frac{37}{160} = 3{\cdot}23125$, $\frac{517}{1600} = {\cdot}323125$, $\frac{517}{16000} = {\cdot}0323125$, $\frac{517}{160000} = {\cdot}00323125$. (2) $\frac{107}{250} = {\cdot}428$, $\frac{107}{2500} = {\cdot}0428$, $\frac{107}{25000} = {\cdot}00428$. (3) $5\frac{211}{320} = 5{\cdot}659375$, $\frac{1811}{3200} = {\cdot}5659375$.

X.

(1) 374·841, 187·4205, 149·9364, 93·71025. (2) 1018·5853125, 254·646328125, 1303·7892, 31·830791015625. (3) 3·6125. (4) ·0015625, ·0001953125, ·002, ·000125. (5) ·0025, ·0000125. (6) ·25, ·125, ·1, ·0625. (7) ·005, ·0025, ·002, ·00125. (8) ·00045625, ·0000045625, ·000000045625. (9) $14\frac{111}{80} = 14{\cdot}1375$.

$9\frac{17}{40} = 9{\cdot}425$, $7\frac{11}{160} = 7{\cdot}06875$, $5\frac{131}{200} = 5{\cdot}655$, $3\frac{171}{320} = 3{\cdot}534375$, $\frac{39}{80} = {\cdot}4875$. (10) $\frac{13}{80} = {\cdot}1625$. $\frac{429}{16000} = {\cdot}0268125$, $\frac{8193}{16384000} = {\cdot}000050006103515625$.

XI.

(1) 4·5625. (2) ·5, ·25, ·2, ·125. (3) 468, 312, 234, 178·2, 117. (4) 31·808046875, 3180·8046875, 318080·46875. (5) ·00015625. (6) 7118580. (7) 4·375. (8) 1·5. (9) 48·75, 487·5, 5·8, 58, ·58. (10) 1, ·1, 10, 25, 4.

XII.

(1) 14*s.* $5\frac{1}{4}d.$ (2) $7\frac{1}{5}d.$ (3) $5\frac{1}{25}$ lbs. (4) 292 days. (5) 14 min. 4·2 sec. (6) $24\frac{1}{2}$ lbs. (7) 112·8512 yards.

XIII.

(1) ·4. (2) ·034375. (3) ·23125. (4) 7·90625. (5) ·571875. (6) ·04690625.

XIV.

(1) 250·5294. (2) 1. (3) $\frac{23}{25}$. (4) $4\frac{711}{800} = 4{\cdot}88875$. (5) ·07884. (6) 3·14159. (7) 14·6984 days. (8) 11 hours, 57 min. 41·76 sec. (9) ·06075. (10) 10. (11) 21 times and ·0015 over. (12) 130 times and ·0016 over. (13) ·00000002635. (14) 43·72875. (15) 1·5625. (16) 72315, ·072315, ·72315, 72315. (17) ·072315, 72315, 7231·5, ·072315. (18) 46·875 fr. (19) 4·125 fr. (20) 1*s.* $2\frac{1}{2}d.$ (21) 1*s.* $8\frac{1}{4}d. = £{\cdot}084375$. (22) £3. 9*s.* 3*d.* (23) ·02646. (24) 1·74. (25) 5·055. (26) *a.* 350. *b.* 10250. *c.* 9750. *d.* ·01. *e.* ·1. *f.* ·5. (27) 173500, 17350, 1735, 1·735, ·1735, ·01735 metres. (28) 100 sq. decimetres, 1000000 c. centimetres. (29) 653 c. yds. 26 ft. 392·9765 in. (30) 2·465. (31) £85. (32) 4 pieces. (33) 3 cwt. 2 qrs. 26 lbs. 1 oz. (34) $64\frac{5856}{7721}$ grains, $1609\frac{1367}{3937}$ metres. (35) 10. (36) ·03835, ·00635, ·0003576, 1·396875. (37) £·5 by ·0001 or $\frac{12}{125}$ f. (38) 1750 fr. (39) 8*s.* $0\frac{1}{4}d.$ (1 gramme being 15·44 grains). (40) 14 cwt. 3 qrs. 2 lbs. 4·4 oz., 360 m. 3 fur. 47 yds. 0 ft. 6·2 in., 2·115298408 acres, £56. 18*s.* $0\frac{1}{4}d.$, 125·4552159 gallons. (41) 11349·675 fr.

XV.

(1) See pp. xvii, xviii. (2) *a.* $\frac{792}{2125}$ inch. *b.* $\frac{24}{2375}$ f.

(1) Reduce $\frac{7}{11}$ to a decimal. $11)\overline{7}\ (\cdot 63$

$\frac{7}{11} > \cdot 6$ by $\frac{2}{55}$ .....A

$\frac{7}{11} > \cdot 63$ by $\frac{7}{1100}$, which reduces the error by ..... $\frac{3}{100}$ ...B

$\frac{7}{11} > \cdot 636$ by $\frac{1}{2750}$, which further reduces the error by $\frac{3}{5000}$ ...C

$\frac{7}{11} > \cdot 6363$ by $\frac{7}{110000}$ " " $\frac{3}{10000}$ ...D

$\frac{7}{11} > \cdot 63636$ by $\frac{1}{275000}$ " " $\frac{3}{50000}$ ...E

$\frac{7}{11} > \cdot 636363$ by $\frac{7}{11000000}$ " " $\frac{3}{1000000}$ ...F

B

ESTIMATE OF ERROR IN DIFFERENT UNITS.

	£. s. d.	lb. av.	Cwt.	Ton.	Yd.	Mile.	7920 miles, Earth's diameter.	93500000 miles, Sun's distance.
A	$8\frac{8}{11}d.$	$9\frac{17}{55}$ dr.	$4\frac{4}{55}$ lbs.	2 qrs. $25\frac{5}{11}$ lbs.	$1\frac{17}{55}$ in.	64 yds.	288 m.	3400000 m.
B	$1\frac{20}{55}d.$	$1\frac{173}{275}$ dr.	$11\frac{111}{275}$ oz.	$14\frac{14}{55}$ lbs.	$\frac{63}{275}$ in.	$11\frac{1}{5}$ yds.	$50\frac{2}{5}$ m.	595000 m.
C	$\frac{96}{275}$ f.	$\frac{128}{1375}$ dr.	$10\frac{586}{1375}$ dr.	$13\frac{9}{275}$ oz.	$\frac{18}{1375}$ in.	$23\frac{11}{275}$ in.	$2\frac{22}{25}$ m.	34000 m.
D	$\frac{84}{1375}$ f.	$\frac{112}{6875}$ dr.	$1\frac{5669}{6875}$ dr.	$2\frac{386}{1375}$ oz.	$\frac{63}{27500}$ in.	$4\frac{4}{125}$ in.	$887\frac{1}{25}$ yds.	5950 m.
E	$\frac{24}{6875}$ f.	$\frac{32}{34375}$ dr.	$\frac{3584}{34375}$ dr.	$2\frac{586}{6875}$ dr.	$\frac{9}{68750}$ in.	$\frac{144}{625}$ in.	$50\frac{86}{125}$ yds.	340 m.
F	$\frac{21}{34375}$ f.	$\frac{28}{171875}$ dr.	$\frac{3136}{171875}$ dr.	$\frac{12544}{34375}$ dr.	$\frac{63}{2750000}$ in.	$\frac{126}{3125}$ in.	$8\frac{544}{625}$ yds.	$59\frac{1}{2}$ m.

(2) Reduce $\frac{5}{13}$ to a decimal.

$$13)\,50\,(\cdot384615$$
$$110$$
$$60$$
$$80$$
$$20$$
$$70$$
$$5$$

$\frac{5}{13} > \cdot3$ by $\frac{11}{130}$ .....A

$\frac{5}{13} > \cdot38$ by $\frac{3}{650}$, which reduces the error by..... $\frac{2}{25}$ ...B

$\frac{5}{13} > \cdot384$ by $\frac{1}{1625}$, which further reduces the error by $\frac{1}{250}$ ...C

$\frac{5}{13} > \cdot3846$ by $\frac{1}{65000}$ " " $\frac{3}{5000}$ ...D

$\frac{5}{13} > \cdot38461$ by $\frac{7}{1300000}$ " " $\frac{1}{100000}$ ...E

$\frac{5}{13} > \cdot384615$ by $\frac{1}{2600000}$ " " $\frac{1}{200000}$ ...F

Estimate of error in Different Units.

	£. s. d.	lb. av.	Cwt.	Ton.	Yd.	Mile.	7920 miles, Earth's diameter.	93500000 miles, Sun's distance.
A	1s. $8\frac{4}{13}d.$	$1\frac{23}{65}$ oz.	$9\frac{31}{65}$ lbs.	1 cwt. 2 qrs. $21\frac{7}{13}$ lbs.	$3\frac{3}{65}$ in.	$148\frac{12}{13}$ yds.	$670\frac{2}{13}$ m.	$7911538\frac{6}{13}$ m.
B	$1\frac{7}{65}d.$	$1\frac{59}{325}$ dr.	$8\frac{88}{325}$ oz.	$10\frac{22}{65}$ lbs.	$\frac{54}{325}$ in.	$8\frac{8}{65}$ yds.	$36\frac{36}{65}$ m.	$431538\frac{6}{13}$ m.
C	$\frac{102}{325}$ f.	$\frac{256}{1625}$ dr.	$1\frac{167}{1625}$ oz.	$1\frac{123}{325}$ lbs.	$\frac{36}{1625}$ in.	$1\frac{27}{325}$ yds.	$4\frac{284}{325}$ m.	$57538\frac{6}{13}$ m.
D	$\frac{24}{1625}$ f.	$\frac{32}{8125}$ dr.	$\frac{3584}{8125}$ dr.	$8\frac{1336}{1625}$ dr.	$\frac{9}{16250}$ in.	$\frac{1584}{1625}$ in.	$214\frac{146}{325}$ yds.	$1438\frac{6}{13}$ m.
E	$\frac{42}{8125}$ f.	$\frac{56}{40625}$ dr.	$\frac{6272}{40625}$ dr.	$3\frac{713}{8125}$ dr.	$\frac{63}{325000}$ in.	$\frac{2772}{8125}$ in.	$75\frac{93}{1625}$ yds.	$503\frac{6}{13}$ m.
F	$\frac{3}{8125}$ f.	$\frac{4}{40625}$ dr.	$\frac{448}{40625}$ dr.	$\frac{1792}{8125}$ dr.	$\frac{9}{650000}$ in.	$\frac{198}{8125}$ in.	$5\frac{587}{1625}$ yds.	$35\frac{25}{26}$ m.

XVI.

(1) ·43072, ·0102Ø, ·4308Ø. (2) ·6667, ·4444, ·2727, ·2778, 4·0909, 4·1. (3) 1, ·0909091, ·001, ·38, ·43, ·36. (4) 1000. (5) ·1, ·06, ·059, ·0588, ·05882, ·058824, ·0588235, ·05882353, ·058823529, ·0588235294, ·05882352941, ·058823529412, ·0588235294118, ·05882352941176, ·058823529411765, ·0588235294117647.

XVII.

(1) $117\frac{43}{180} = 117{\cdot}23889$. (2) $38\frac{970}{1287} = 38{\cdot}75368$. (3) $46\frac{289}{1386} = 46{\cdot}20851$. (4) $33\frac{32}{105} = 33{\cdot}30476$. (5) $62\frac{3}{10} = 62{\cdot}3$. (6) $5\frac{6}{7} = 5{\cdot}8571$. (7) $\frac{43}{126} = {\cdot}34127$. (8) $9\frac{37}{75} = 9{\cdot}49333$. (9) $\frac{62}{75} = {\cdot}82667$. (10) $3\frac{67}{154} = 3{\cdot}43506$. (11) $2\frac{11}{15} = 2{\cdot}73333$. (12) $13\frac{3}{5} = 13{\cdot}6$. (13) $\frac{124660}{153153} = {\cdot}813957$. (14) 1·2869695. (15) ·2401961. (16) ·6511628. (17) 2·1032. (18) ·5763. (19) 80·668. (20) 27·43448. (21) ·5. (22) 2. (23) 2·718281828. (24) 3·14159.

XVIII.

(1) 3·333, 333·333, 33333·333. (2) 47·2727, 472·7273, 4727272·7273. (3) $58\frac{8}{9} = 58{\cdot}888889$, $588\frac{8}{9} = 588{\cdot}888889$, $58888\frac{8}{9} = 58888{\cdot}888889$. (4) $5\frac{5}{6} = 5{\cdot}833333$, $58\frac{1}{3} = 58{\cdot}333333$, $5833\frac{1}{3} = 5833{\cdot}333333$. (5) $9285\frac{5}{7} = 9285{\cdot}714286$. (6) $29\frac{7}{17} = 29{\cdot}411765$. (7) $128\frac{8}{9} = 128{\cdot}888889$.

XIX.

(1) $4307\frac{9}{13} = 4307{\cdot}6923$. (2) $71\frac{3}{7} = 71{\cdot}4286$. (3) $50909\frac{1}{11} = 50909{\cdot}0909$. (4) 4000. (5) 25000. (6) $2650\frac{5}{12} = 2650{\cdot}4167$. (7) $1621\frac{28}{37} = 1621{\cdot}6216$. (8) $87857\frac{1}{7} = 87857{\cdot}1429$. (9) $19636363\frac{7}{11} = 19636363{\cdot}6364$. (10) 1715·6566. (11) 1666844·4444. (12) 23543·5435.

XX.

(1) $11389\frac{28}{41} = 11389{\cdot}6829$. (2) $575\frac{13}{29} = 575{\cdot}4483$. (3) $4118\frac{2}{11} = 4118{\cdot}1818$. (4) 2814. (5) 100500. (6) $110204\frac{97}{128} = 110204{\cdot}7578$.

XXI.

(1) $44\frac{47}{77} = 44{\cdot}61039$. (2) $2\frac{27}{39} = 2{\cdot}94872$. (3) $1\frac{13}{120} = 1{\cdot}10833$. (4) $\frac{641}{665860} = {\cdot}00098$. (5) $24767283\frac{485633}{3200000} = 24767283{\cdot}15176$. (6) $\frac{11}{1738150} = {\cdot}00001$. (7) ·19006. (8) 4·88461862. (9) 3·97932. (10) ·016. (11) ·49426. (12) 140378.

XXII.

(1) 74·35878788, ·74358788, ·00074359. (2) ·20944. (3) ·002114. (4) ·01784512 (5) ·16838. (6) 259·7403. (7) 4734·54545, 47345·45455, 47345454·54545. (8) ·0000793651. (9) 37·4152. (10) 646·20176. (11) 13·227513. (12) 1·02222. (13) ·000023. (14) ·3466842, ·0034668. (15) 34·6715136, 3·4671514, ·3467151. (16) 1·514454894, ·000813318. (17) 1·5144316731, ·0008133059, ·0015144317, 813·3058984911. (18) ·289. (19) ·014957, ·001496, 149·57265. (20) ·01196581, ·11965812, 1·1965812, ·00001197. (21) 0.

XXIII.

(1) 20·6134. (2) 2·03Ø. (3) 38·144. (4) 15·3627. (5) ·05. (6) 8·10292. (7) 14527. (8) ·15965. (9) ·857143. (10) ·00000007. (11) 2·333333. (12) $3\frac{2}{3} = 3{\cdot}66667$, $1\frac{1}{27} = 1{\cdot}03704$, $\frac{2}{3} = {\cdot}66667$, 49, $\frac{3}{11} = {\cdot}27273$, $\frac{27}{28} = {\cdot}96429$, $1\frac{1}{2} = 1{\cdot}5$, $\frac{1}{49} = {\cdot}02041$, $1\frac{8}{55} = 1{\cdot}14545$, $\frac{55}{63} = {\cdot}87302$. (13) 1422 years, 302 years.

XXIV.

(1) 500500. (2) 139. (3) 10000. (4) $2422\frac{1}{2}$. (5) 67·5. (6) 22·25. (7) £60, £330. (8) 788·9 ft.

XXV.

(1) 3280. (2) 1111111·111. (3) 3905. (4) 6·8019.

XXVI.

(1) $1\frac{1093}{21870}$. (2) $1\frac{156}{625}$. (3) 1111·111111. (4) 3·333333333.

XXVII.

(1) $1\frac{1}{4}$. (2) $4\frac{1}{12}$. (3) 16. (4) $73\frac{1}{7}$. (5) 1. (6) 30.

XXVIII.

(1) $\frac{1}{3}$. (2) $\frac{7}{9}$. (3) $\frac{1}{9}$. (4) $\frac{2}{9}$. (5) $\frac{2}{3}$. (6) 1. (7) $\frac{3}{11}$. (8) $\frac{8}{11}$. (9) $\frac{5}{37}$. (10) $\frac{26}{111}$. (11) $\frac{8}{333}$. (12) $\frac{2}{27}$. (13) $\frac{1}{7}$. (14) $\frac{6}{7}$. (15) $\frac{3}{7}$. (16) $\frac{2}{13}$. (17) $\frac{131}{909}$. (18) $\frac{1}{41}$. (19) $\frac{1}{73}$. (20) $\frac{5}{63}$. (21) $\frac{7}{2439}$. (22) $\frac{1}{91}$. (23) $\frac{468}{11111}$. (24) $\frac{1}{3861}$.

XXIX.

(1) $\frac{1}{30}$. (2) $\frac{4}{55}$. (3) $\frac{1}{275}$. (4) $\frac{2}{555}$. (5) $\frac{1357}{1111100}$. (6) $\frac{1}{10000}$. (7) $\frac{1}{9225}$. (8) $\frac{3}{277750}$.

XXX.

(1) $\frac{3}{22}$. (2) $\frac{69}{110}$. (3) $\frac{26}{55}$. (4) $\frac{17}{36}$. (5) $\frac{13}{275}$. (6) $\frac{6557}{99900}$. (7) $\frac{2237}{9900}$. (8) $\frac{61}{270}$. (9) $\frac{113}{500}$. (10) $\frac{7}{12}$. (11) $\frac{5}{12}$. (12) $\frac{1}{600}$. (13) $\frac{11}{12}$. (14) $\frac{1}{12}$. (15) $\frac{5}{6}$. (16) $\frac{289}{495}$.

XXXI.

·025, ·05, ·075, ·1, ·125, ·15, ·175, ·2, ·225, ·25, ·275, ·3, ·325, ·35, ·375, ·4, ·425, ·45, ·475, ·5, ·525, ·55, ·575, ·6, ·625, ·65, ·675, ·7, ·725, ·75, ·775, ·8, ·825, ·85, ·875, ·9, ·925, ·95, ·975.

XXXII.

·0010416̇, ·002083̇, ·003125, ·0041̇6, ·0052083̇, ·00625, ·0072916̇, ·0083̇, ·009375, ·0104166̇, ·0114583̇, ·0125, ·0135416̇, ·0145833̇, ·015625, ·016̇, ·0177083̇, ·01875, ·0197916̇, ·02083̇, ·021875, ·0229166̇, ·0239583̇, ·025.

XXXIII.

(1) ·425, ·875, ·675, ·225, ·075. (2) ·6625, ·5625, ·9625, ·7875, ·9375, ·0875. (3) ·721875, ·59375, ·93125, ·196875. (4) ·0̇3̇, ·0416̇, ·02916̇, ·0145833̇, ·05416̇, ·3̇6̇. (5) ·67083̇, ·8927083̇, ·789583̇, ·685416̇, ·097916̇, ·0010416̇, ·002083̇, ·00416̇, ·8510416̇, ·552083̇, ·6010416̇.

XXXIV.

(1) £4. 5*s.*, £42. 10*s.*, £425, £4250, £42500, £425000. (2) £4. 14*s.* 4½*d.*, £47. 3*s.* 9*d.*, £471. 17*s.* 6*d.*, £4718. 15*s.*, £47187. 10*s.*, £471875. (3) £28. 13*s.* 9*d.*, £286. 17*s.* 6*d.*, £2868. 15*s.*, £28687. 10*s.*, £286875, £2868750. (4) £30.16*s.* 10½*d.*, £308. 8*s.* 9*d.*, £3084. 7*s.* 6*d.*, £30843. 15*s.*, £308437. 10*s.*, £3084375. (5) £8. 3*s.* 1½*d.*, £81. 11*s.* 3*d.*, £815. 12*s.* 6*d.*, £8156. 5*s.*, £81562. 10*s.*, £815625. (6) £46. 13*s.* 1½*d.*, £466. 11*s.* 3*d.*, £4665. 12*s.* 6*d.*, £46656. 5*s.*, £466562. 10*s.*, £4665625. (7) £1. 6*s.* 0½*d.*, £13. 0*s.* 5*d.*, £130. 4*s.* 2*d.*, £1302. 1*s.* 8*d.*, £13020. 16*s.* 8*d.*, £130208. 6*s.* 8*d.* (8) £1. 15*s.* 10*d.*, £17. 18*s.* 4*d.*, £179. 3*s.* 4*d.*, £1791. 13*s.* 4*d.*, £17916. 13*s.* 4*d.*, £179166. 13*s.* 4*d.* (9) £2. 7*s.* 3½*d.*, £23. 12*s.* 11*d.*, £236. 9*s.* 2*d.*, £2364. 11*s.* 8*d.*, £23645. 16*s.* 8*d.*, £236458. 6*s.* 8*d.* (10) £2. 18*s.* 11½*d.*, £29. 9*s.* 7*d.*, £294. 15*s.* 10*d.*, £2947. 18*s.* 4*d.*, £29479. 3*s.* 4*d.*, £294791. 13*s.* 4*d.* (11) £3. 3*s.* 4*d.*, £31. 13*s.* 4*d.*, £316. 13*s.* 4*d.*, £3166. 13*s.* 4*d.*, £31666. 13*s.* 4*d.*, £316666. 13*s.* 4*d.* (12) 14*s.* 7*d.*, £7. 5*s.* 10*d.*, £72. 18*s.* 4*d.*, £729. 3*s.* 4*d.*, £7291. 13*s.* 4*d.*, £72916. 13*s.* 4*d.* (13) £2. 1*s.* 8*d.*

£20. 16*s.* 8*d.*, £208. 6*s.* 8*d.*, £2083. 6*s.* 8*d.*, £20833. 6*s.* 8*d.*, £208333. 6*s.* 8*d.* (14) £3. 0*s.* 10*d.*, £30. 8*s.* 4*d.*, £304. 3*s.* 4*d.*, £3041. 13*s.* 4*d.*, £30416. 13*s.* 4*d.*, £304166. 13*s.* 4*d.* (15) £4. 0*s.* 2½*d.*, £40. 2*s.* 1*d.*, £401. 0*s.* 10*d.*, £4010. 8*s.* 4*d.*, £40104. 3*s.* 4*d.*, £401041. 13*s.* 4*d.* (16) £6. 0*s.* 5*d.*, £60. 4*s.* 2*d.*, £602. 1*s.* 8*d.*, £6020. 16*s.* 8*d.*, £60208. 6*s.* 8*d.*, £602083. 6*s.* 8*d.*

XXXV.

I. (1) £2801. 7*s.* 3½*d.* (2) £6871. 13*s.* 10*d.* (3) £26121. 4*s.* 10½*d.* (4) £52. 7*s.* 11¾*d.* (5) £46733. 13*s.* 4*d.* (6) £3808. 18*s.* 11¼*d.* (7) £21403. 5*s.* 2*d.* (8) £2005. 10*s.* (9) £865. 8*s.* 11½*d.* (10) £913. 6*s.* 4½*d.*

II. (1) £3237. 4*s.* 0¾*d.* (2) £3809. 10*s.* 3¼*d.* (3) £6744. 10*s.* 9½*d.* (4) £1568. 15*s.* 10¾*d.* (5) £10523. 11*s.* 8¼*d.* (6) £6556. 1*s.* 8*d.* (7) £176. 5*s.* 10½*d.* (8) £102. 14*s.* 8¼*d.* (9) £188. 17*s.* 5¼*d.* (10) £730. 15*s.* 10¾*d.* (11) £413. 0*s.* 10*d.*

III. (1) £15541. 19*s.* 0¼*d.* (2) £1174. 18*s.* (3) £10438. 0*s.* 7¾*d.* (4) £8004. 10*s.* 7¼*d.* (5) £8261. 12*s.* 4¼*d.* (6) £13935. 2*s.* 1¾*d.* (7) £4375. 19*s.* 0¼*d.* (8) £2141. 3*s.* 9¾*d.* (9) £7202612. 16*s.* 0½*d.* (10) £22847. 7*s.* 1½*d.*

XXXVI.

(1) £1150. 2*s.* 2*d.* (2) £5105. 13*s.* 1¼*d.* (3) £11978. 8*s.* 5*d.* (4) £3011. 13*s.* 3½*d.* (5) £372. 17*s.* 0¾*d.* (6) £468. 0*s.* 9¼*d.* (7) £245. 14*s.* 5*d.* (8) £3338. 4*s.* 8¼*d.* (9) £5952. 7*s.* 7¼*d.* (10) £2898. 18*s.* 8*d.* (11) £9485. 9*s.* 6½*d.* (12) £20273. 9*s.* 0¾*d.*

XXXVIII.

(1) £237. 6*s.* 9*d.* (2) £3449. 18*s.* 8½*d.* (3) £11. 16*s.* 5½*d.* (4) £7. 17*s.* 5½*d.* (5) £5. 18*s.* 5¾*d.* (6) £4. 10*s.* 5¾*d.* (7) £183. 18*s.* 1½*d.* (8) £636. 17*s.* 9¾*d.* (9) £569. 5*s.* 9½*d.* (10) £15. 8*s.* 11½*d.*

XXXIX.

(1) £64. 19*s.* 0¼*d.* (2) £120. 9*s.* 11*d.* (3) £633. 10*s.* 0½*d.* (4) £74. 3*s.* 5¾*d.* (5) £4490. 15*s.* 10*d.* (6) £8. 13*s.* 4½*d.* (7) £10. 1*s.* 8¼*d.* (8) £7. 7*s.* 6*d.* (9) £4. 5*s.* 4¼*d.* (10) £9. 3*s.* 2¾*d.*

XL.

(1) £13. 17*s.* 3¾*d.* (2) £6. 16*s.* 4¾*d.* (3) £297. 7*s.* 0¾*d.* (4) £12*s.* 6*s.* 6*d.* (5) £111. 1*s.* 8½*d.* (6) £2153. 5*s.* 9¾*d.* (7) £325. 1*s.* 4*d.* (8) £4. 16*s.* 1¼*d.* (9) £3312.

XLI.

(1) £18. 11*s.* 5¾*d.* (2) £9. 2*s.* 9¾*d.* (3) £1. 11*s.* 1½*d.* (4) £99. 10*s.* 2¼*d.* (5) £113. 19*s.* 2¾*d.* (6) £26. 1*s.* 8½*d.*

XLII.

(1) £146. 17*s.* 7*d.* (2) £47. 11*s.* 11¼*d.* (3) £77. 1*s.* 3¼*d.* (4) £14. 19*s.* 0¾*d.* (5) £79. 12*s.* 3¾*d.* (6) £625. 10*s.* 6¼*d.*

XLIII.

(1) 13*s.* 11¾*d.* (2) 11*d.* (3) £4. 4*s.* 7½*d.* (4) £1146. 1*s.* 5*d.* (5) £732. 18*s.* 11½*d.*

XLIV.

(1) £3. 5*s.* 5½*d.* (2) £40. 8*s.* 5¾*d.* (3) £974. 13*s.* 8¾*d.* (4) £242732. 16*s.* 3*d.* (5) £7. 13*s.* 3¾*d.* (6) £5. 8*s.* 2¼*d.* (7) £154. 7*s.* 6*d.* (8) £115. 6*s.* 7*d.*

XLV.

(1) £1611. 0*s.* 3¾*d.* (2) £1124. 6*s.* 5*d.* (3) £15392. 14*s.* 0¾*d.* (4) £34. 9*s.* 2¼*d.*

XLVII.

(1) £15. 8*s.* (2) £25. 16*s.* 7*d.* (3) £4. 3*s.* 2*d.* (4) £9. 16*s.* 10½*d.* (5) £11. 16*s.* 1¼*d.* (6) £64. 17*s.* 6*d.* (7) £2. 11*s.* 8*d.* (8) £183. 15*s.* (9) £27. 5*s.* 9*d.* (10) £319. 9*s.* 2*d.* (11) £4507. 12*s.* 4¼*d.* (12) 24,436 births.

XLVIII.

I. (1) £35. (2) £35. (3) £31. 11*s.* 1½*d.* (4) £20. 1*s.* 4*d.* (5) £48. 12*s.* 3*d.* (6) £6. 2*s.* 4½*d.*

II. (1) 2*s.* 9¾*d.* (2) £1. 16*s.* 4½*d.* (3) 10*s.* 8½*d.* (4) £1. 14*s.* 6¼*d.* (5) £109. 4*s.* 2¾*d.* (6) £12. 14*s.* 2¾*d.*

III. (1) £223. 3*s.* (2) £63. 8*s.* 3½*d.* (3) 16*s.* 6¼*d.* (4) £1. 4*s.* 1¾*d.* (5) £13. 5*s.* 5½*d.* (6) £2. 1*s.* 7*d.*

IV. (1) £1615. 5*s.* (2) £1871. 19*s.* 3¾*d.* (3) £2060. 12*s.* 6¾*d.* (4) £444. 13*s.* 8½*d.* (5) £259. 18*s.* 8*d.* (6) £7898. 9*s.*

V. £41. 13*s.* 4*d.*

XLIX.

(1) 20·482 %. (2) 3·614 %. (3) £4000. (4) £40. 4*s.* 9*d.* (5) £46. 15*s.* 3*d.* (6) 22·975 % gain. (7) 12 %. (8) $\frac{3}{8}$ %. (9) £1720. (10) 66 boys. (11) £3. 9*s.* 2*d.* (12) None. (13) 6·9 % decrease. (14) *a.* £9. 7*s.* $10\frac{3}{20}$*d.* *b.* 3·70$\dot{3}$, 16·$\dot{6}$, 17·379, 25, 43·59, 23·077, 18·5$\dot{1}\dot{8}$, 29·719%. *c.* 21·390 %. (15) 3·809 %.

L.

(1) 1 month. (2) 222 days. (3) $3\frac{1}{3}$ years. (4) 7 %. (5) £10632. 18*s.* $2\frac{3}{4}$*d.* (6) £9. 6*s.* $5\frac{3}{4}$*d.*%. (7) £912. (8) *a.* £2. 1*s.* 11*d.* *b.* £1093. 15*s.* *c.* $3\frac{3}{4}$%. *d.* 217 days.

LI.

(1) *a.* £423. 16*s.* 4*d.* *b.* £6260. 15*s.* 9*d.* *c.* £775. 3*s.* 5*d.* *d.* £81. 16*s.* $5\frac{3}{4}$*d.* *e.* £441. 1*s.* $11\frac{3}{4}$*d.* *f.* £1238. 16*s.* $10\frac{1}{2}$*d.* (2) *a.* £5. 19*s.* $9\frac{1}{2}$*d.* *b.* £4. 15*s.* $2\frac{1}{2}$*d.* *c.* 1*s.* 2*d.* *d.* £14. 13*s.* 7*d.* (3) *a.* £622. 18*s.* $0\frac{3}{4}$*d.* *b.* £483. 9*s.* $8\frac{1}{2}$*d.* *c.* £369. 17*s.* 1*d.* (4) *a.* $8\frac{1}{4}$*d.* *b.* 3*s.* 5*d.* *c.* 11*s.* $2\frac{1}{2}$*d.*

LII.

(1) 18*s.* 9*d.* (2) 3*s.* 10*d.* (3) £651. 5*s.* $7\frac{3}{4}$*d.* (4) £105. 5*s.* $3\frac{1}{4}$*d.* (5) £70. 6*s.* 3*d.* (6) 18 %. (7) £816. 13*s.* 4*d.* (8) 3·96*d.* (9) 19*s.* 2*d.* (10) 50 %. (11) 5·5$\dot{6}\dot{3}$ pence. (12) 4 %. (13) 43·119 % gain. (14) $5\frac{1}{3}$ apples. (15) 419·388 fr.

LIII.

(1) £9061. 13*s.* 3*d.* (2) £833. 3*s.* $1\frac{3}{4}$*d.* (3) £320. 5*s.* (4) £59. 17*s.* 4*d.*

LIV.

(1) £7901. 3*s.* 9*d.* (2) £687. 3*s.* 5*d.* (3) £754. 10*s.* $4\frac{1}{2}$*d.* (4) £677. 11*s.* $9\frac{1}{2}$*d.* (5) £539. 5*s.* (6) £847. 7*s.* $11\frac{1}{2}$*d.* (7) £576. 13*s.* 4*d.* (8) £25030. 13*s.* 5*d.*

LV.

(1) £30732600. (2) *a.* £1500 loss. *b.* 0. *c.* £1548 gain. *d.* 405 francs gain.

LVI.

(1) £42. 12*s.* $4\frac{3}{4}$*d.* (2) £327. 17*s.* $4\frac{3}{4}$*d.* (3) £76. 14*s.* $6\frac{1}{4}$*d.* (4) £2808. 15*s.* (5) £3760. 14*s.* $3\frac{1}{2}$*d.* (6) £42. 11*s.* $4\frac{1}{2}$*d.*, £327. 8*s.* $5\frac{1}{4}$*d.*, £76. 10*s.* $7\frac{1}{4}$*d.*, £2812. 10*s.*, £3766. 1*s.* $5\frac{1}{4}$*d.* (7) *a.* 3·394%. *b.* 4·484 %. *c.* 5·681 %. *d.* 5·232 %. *e.* 7·362 %. *f.* 12·987 %.

LVII.

(1) *a.* 4 per cents. *b.* $3\frac{1}{2}$ per cents. *c.* $5\frac{3}{4}$ per cents. (2) *a.* 5*s.* $1\frac{1}{2}$*d.* *b.* £1. 14*s.* 8*d.* *c.* £4. 9*s.* $8\frac{1}{2}$*d.* (3) £50. 8*s.* 11*d.*

LVIII.

(1) £113. 15*s.* $8\frac{1}{2}$*d.* (2) £86. 9*s.* $8\frac{1}{2}$*d.* (3) £80. 14*s.* (4) £49. 0*s.* $4\frac{1}{4}$*d.* (5) £149. 3*s.* 4*d.* (6) £60. 17*s.* 5*d.*

LIX.

(1) £2014. 16*s.* 8*d.* decrease, £17. 0*s.* 2*d.* increase, 6*s.* $5\frac{3}{4}$*d.* % increase. (2) £4947. 5*s.* $3\frac{1}{4}$*d.* increase, 14*s.* $4\frac{3}{4}$*d.* increase, $3\frac{1}{2}$% increase. (3) £51. 3*s.* decrease, £4. 17*s.* 1*d.* increase, 18*s.* $4\frac{3}{4}$*d.* increase. (4) £428. 2*s.* 7*d.* decrease, £2. 17*s.* 1*d.* increase, 1*s.* $9\frac{3}{4}$% increase. (5) £743. 15*s.* 10*d.* decrease, 0, 0. (6) £9455. 12*s.* 11*d.* increase, £682. 15*s.* $7\frac{3}{4}$*d.* increase, £7. 7*s.* 2*d.* increase.

LX.

(1) £18. 7*s.* 6*d.* (2) $83\frac{1}{3}$. (3) $15\frac{3}{7}$%. (4) *a.* £4. 16*s.* $4\frac{3}{4}$*d.* *b.* £5. 0*s.* $9\frac{3}{4}$*d.* *c.* £4. 15*s.* $2\frac{1}{2}$*d.* *d.* £3. 14*s.* $7\frac{1}{2}$*d.* (5) £8. 13*s.* (6) £36. 17*s.* $3\frac{1}{2}$*d.* (7) £5787. 9*s.* 3*d.* (8) $72\frac{7}{8}$. (9) £16500 stock, £14746. 17*s.* 6*d.* (10) £1024. 4*s.* 8*d.* (11) £137. 16*s.* $11\frac{1}{2}$*d.* (12) $93\frac{5}{8}$. (13) $107\frac{3}{8}$. (14) £16. 1*s.* loss. (15) Decrease in capital, £84. 18*s.* 11*d.*, increase in income, £25. 6*s.* $7\frac{1}{4}$*d.* (16) $90\frac{1}{2}$. (17) 95·677. (18) £2035. 2*s.* 6*d.* (19) £457. 9*s.* 3*d.* stock, commission, 11*s.* $5\frac{1}{4}$*d.* (20) £8. 4*s.* 6*d.* %, dividend £91. 16*s.* (21) £502. 2*s.* 10*d.*

LXI.

(1) 2. (2) 7. (3) 10. (4) 30. (5) 400. (6) 5000. (7) 13. (8) 17. (9) 57. (10) 123. (11) 763. (12) 247. (13) 978. (14) 8276. (15) 534762. (16) 708. (17) 40093. (18) 203975. (19) 3100. (20) 11111. (21) 53784912. (22) 93. (23) 1 furlong.

LXII.

(1) 70 and 100 over. (2) 41. (3) 79, 476, 11, 287, 1. (4) 55696, 81796, 9998244, 123454321, 776161, 4853209.

LXIII.

I. (1) 1·7320. (2) 4·3589. (3) 3·3166. (4) 2·2638. (5) 2·7018.

II. (1) 1·41421356, ·44721359, ·14142135, ·04472136. (2) &c.

1·26491106, ·4, ·12649110, ·00126491. (3) ·40824829, ·40201512, ·12655439. (4) ·6̇, ·4̇, ·16̇.

III. (1) $1\frac{3}{4}$. (2) $1\frac{2}{15}$. (3) $7\frac{1}{5}$. (4) $3\frac{8}{9}$.

IV. (1) ·790569415048. (2) ·606976978666. (3) ·072760687510. (4) ·707106781187. (5) ·577350269189. (6) ·182574185835. (7) ·057735026919. (8) ·05. (9) ·015811388301. (10) ·125590089825.

V. (1) 8·616. (2) ·024. (3) 145. (4) 15. (5) 1·653. (6) ·765. (7) ·707. (8) ·603. (9) 31·622. (10) 2·773.

VI. (1) 60. (2) 1·141. (3) 70. (4) $3\frac{3}{7}$.

LXIV.

(1) 30 ft. (2) 181 ft. (3) 26 inches. (4) 1 inch. (5) 61 ft. (6) *a.* 187·3499. *b.* ·7071. *c.* 2. (7) 325 ft. (8) 141·4213. (9) 70·7106. (10) 86·6025. (11) 115·47. (12) 546 ft.

LXV.

(1) 41. (2) 48. (3) 59. (4) 84. (5) 73. (6) 67. (7) 15. (8) 22. (9) 38.

LXVI.

I. (1) 96. (2) 343. (3) 106. (4) 2009. (5) 4865. (6) ·258. (7) ·0016. (8) 401.

II. (1) ·875. (2) ·03̇7̇. (3) ·7631. (4) 1·0861. (5) ·941ø. (6) 2·5022. (7) ·9499. (8) ·4641. (9) ·2154. (10) ·1.

III. (1) 23. (2) $13\frac{1}{2}$ square yards.

LXVII.

(1) *a.* £48. 9*s.* 5*d.* *b.* £628. 17*s.* $10\frac{3}{4}$*d.* *c.* £3. 1*s.* $4\frac{3}{4}$*d.* *d.* £13. 4*s.* 4*d.* *e.* £130. 15*s.* $5\frac{1}{4}$*d.* *f.* £73. 5*s.* 2*d.* (2) £10. 0*s.* $0\frac{3}{4}$*d.* (3) £10. 6*s.* 5*d.* (4) £124. 17*s.* $4\frac{1}{2}$*d.*, £126. 3*s.* 4*d.*, £126. 16*s.* 6*d.*

LXVIII.

(1) *a.* £411. 7*s.* *b.* £679. 6*s.* $2\frac{1}{2}$*d.* *c.* £884. 1*s.* $5\frac{1}{4}$*d.*

LXIX.

(1) *a.* 33·452 kilog. *b.* 81·705 Russian lbs. *c.* 59·707 Austrian lbs. *d.* 71·525 Prussian lbs. (2) *a.* 25 tons, 4 cwt. 1 qr. 17 lbs. *b.* 52·156 Russian packen. (3) 1*s.* $9\frac{1}{4}$*d.* (4) 6*s.* 9*d.* (5) 18·307 fr. (6) 254·693 litres. (7) 30·022 in. (8) 2 a. 1 r. 35·38288 sq. p., 4·61712 poles. (9) 39·37079 in. (10) 6·367 grains. (11) 1 hectolitre = 1 cubic metre, 37141·2 gallons. (12) $4\frac{3}{4}$*d.* (13) 2·751211

bushels, 8*s.* 4¼*d.* (14) 7 m. 4 fur. 164 yds. (15) 10·63 inches, 48501·6 lbs. (16) £2. 9*s.* 9*d.* (17) 23·302 miles. (18) 1·037 kilogs. (19) 6*d.* (£·0245). (20) 16*s.* 10*d.*

LXX.

(1) 183959. (2) 2649186966618. (3) 3165·3502. (4) ·6. (5) 35000. (6) *a.* 393351 and 15 over, 257713 and 7 over, 191632 and 36 over, 152524 and 8 over, 126672 and 36 over. *b.* 1138411 and 28 over, 45317 and 4134 over, 567778 and 395 over, 56777 and 3587 over. *c.* 86300649 and 82 over, 8552316 and 649 over, 854461 and 8794 over. *d.* 47181 and 76 over, 4637 and 725 over, 462 and 6586 over. *e.* 55316 and 518 over, 5549 and 1495 over, 5493 and 6432 over. (7) 7·78048, 406·461|538, 310·82352941|17647058, 278·105263157|894736842, 229·73913043478|26086956521, 170·451612903225806, 112·425531914893617021276597|57446808510638297872340, 10·674, 1·763096429. (8) ·0073036518259, ·047522750254, ·0119095276220976.

MISCELLANEOUS EXAMPLES.

(1) *a.* $36\frac{347}{800} = 36{\cdot}43375$. *b.* $2\frac{149}{160} = 2{\cdot}93125$. *c.* $\frac{3}{32000} = {\cdot}00009375$, $1562\frac{1}{2} = 1562{\cdot}5$. *d.* $4\frac{3}{8} = 4{\cdot}375$, $7\frac{13}{16} = 7{\cdot}8125$, $78\frac{1}{8} = 78{\cdot}125$. (2) $\frac{5}{37}, \frac{17}{111}, \frac{1}{74}, \frac{79}{370}, \frac{15}{1111}, \frac{61}{4500}, \frac{23}{1500}$. (3) *a.* £9203. 19*s.* 2½*d.* *b.* £11163. 2*s.* 6¼*d.* *c.* £6075. 19*s.* 4*d.* *d.* £240. 9*s.* 6¾*d.* *e.* £45. 6*s.* 6¾*d.* *f.* £3. 3*s.* 4½*d.* *g.* £24. 15*s.* 5¾*d.* (4) 437·962. (5) 2·4898. (6) 6·928. (8) £29. 8*s.* 0½*d.*, £31. 7*s.* 9*d.*, £32. 2*s.* (9) ·027. (11) ·66. (12) 16·503. (13) ·184390888. (14) 247½. (15) $\frac{43}{111}$. (16) $1\frac{13}{47}$ days, $\frac{20}{47}, \frac{15}{47}, \frac{12}{47}$. (17) £1660. 15*s.* 0¾*d.* (18) ·32504. (19) £3. 9*s.* 0½*d.* (20) 326·4. (21) 10 years. (22) ·864. (23) 5¾*d.* (24) ·4875, 7605. (25) £6. 13*s.* 5*d.* (26) £1072, £8. 18*s.* 8*d.*%. (27) *a.* 610. *b.* 3·333333333. (28) 3*s.* 9½*d.* (29) 42 ft. (30) 10*s.* 6*d.* (31) ·028. (32) 19½ days. (33) 30 hours, 5 days. (34) 15 in., 6¼ in., 5⅝ sq. in. (35) $25\frac{10}{11}$, $\frac{2}{3}$, $1\frac{13}{15}$. (36) £16. 8*s.* 9*d.*, 414·554 francs, 109·583 thalers. (37) 5. (38) ·507936, ·285714. (39) £585. 2*s.* 1½*d.* (40) *a.* $2\frac{22}{25}$ f., $2\frac{10}{11}$ f., $2\frac{98}{111}$ f., $3\frac{1}{5}$ f. *b.* 1 cwt. 2 qrs. $18\frac{2}{3}$ lbs., 1 cwt. 2 qrs. $19\frac{79}{99}$ lbs., 1 cwt. 2 qrs. $18\frac{526}{999}$ lbs. *c.* 5 oz., 4 oz. 19 dwt. $22\frac{62}{111}$ grs. *d.* 2·5344 drs., $2\frac{14}{25}$ drs. *e.* $3\frac{17}{37}$ gills, $3\frac{181}{2775}$ gills. (41) $43\frac{487}{1665}$.

(42) The latter. (43) $\frac{63}{64}$. (44) 24 sq. ft. 108 in. (45) £1351. 2*s.* 8$\frac{1}{4}$*d.* (46) 1407, 2·6692, ·6546, ·5, ·5916, ·005, ·1581, ·0316. (47) £1. 8*s.* 1$\frac{1}{2}$*d.* (48) 160 Napoleons = £127. (49) 46·36321. (50) £2. 5*s.* (51) 7038*t*4. (52) 10124$\frac{31}{36}$. (53) N.W., G.N., G.E., S.W., G.W. (54) G.N., N.W., S.W., G.E., G.W. (55) 2$\frac{1}{4}$*d.* (56) £270. 0*s.* 10*d.* (57) £9. (58) 408 yards. (59) £315. (60) 1119744. (61) 157464. (62) ·5. (63) £6. 2*s.* 6*d.* (64) £91. 17*s.* 9*d.*, 6*s.* 8$\frac{1}{2}$*d.* (65) 7$\frac{1}{2}$ years. (66) £419. 16*s.* 9*d.* (67) ·515625. (68) £1303. 6*s.* 8*d.* (69) £27. 8*s.* 6$\frac{3}{4}$*d.* (70) £245.5*s.*5*d.* (71) 20 years, 15 years. (72) 2*s.* 1*d.* (73) 2·3016. (74) £148. 15*s.* 0$\frac{1}{4}$*d.* (75) 62·516 cwt. of copper, 6·86 cwt. of tin. (76) £24. (77) $\frac{13}{29}$, $\frac{41}{456}$. (78) 1330. (79) 17·291 miles. (80) £23. 2*s.* 5$\frac{1}{4}$*d.* each officer, £17. 6*s.* 10*d.* each midshipman, £6. 7*s.* 2*d.* each sailor. (81) 13*s.* 8$\frac{2}{3}$*d.* in the £, £346. 0*s.* 7*d.* (82) £92722. (83) 3 %. (84) 2 hrs. 48 min. (85) £569. 13*s.* 11*d.* (86) £40. 14*s.* 10$\frac{1}{4}$*d.*, 5·03 %. (87) £13750. (88) £18. 8*s.* 3$\frac{1}{2}$*d.*, £27. 13*s.* 9$\frac{1}{2}$*d.* (89) 413·25714, 24·19800. (90) 1·00486944. (91) 49177328·3519. (92) £2067. 10*s.* (93) 7*s.* 6*d.* (94) £9898. (95) £1000. (96) £1. 13*s.* 10$\frac{1}{2}$*d.* (97) 35·410714285. (98) 5$\frac{3}{4}$*d.* (99) Half-past four. (100) 12$\frac{1}{9}$. (101) ·00298828125. (102) 160 men. (103) £5 loss. (104) *a.* £284. 4*s.* 2$\frac{1}{2}$*d.* *b.* £315. 15*s.* 9$\frac{1}{2}$*d.* (105) £474. 8*s.* 5$\frac{1}{2}$*d.*, £363. 0*s.* 8$\frac{1}{2}$*d.*, £412. 10*s.* 10*d.* (106) £235. 17*s.* 3*d.*, £285. 17*s.* 10$\frac{1}{2}$*d.*, £238. 4*s.* 10$\frac{1}{2}$*d.* (107) 9*s.* 8$\frac{1}{2}$*d.*, £29. 6*s.* 7$\frac{1}{2}$*d.* (108) 50 %. (109) 14 yds. 1 ft. (110) 55734, 208577. (111) ·21785. (112) 2557 times. (113) £11. 13*s.* 4*d.* (114) £978. 2*s.* 6*d.* (115) 34·56, $\frac{12}{13}$. (116) 9. (117) 4$\frac{4}{9}$° C, 3$\frac{5}{9}$° R, −40° C, −32° R. (118) £5453. 13*s.* 5$\frac{3}{4}$*d.* (119) £345. (120) £84. 8*s.* 3$\frac{1}{4}$*d.*, £2593. 16*s.* 0$\frac{1}{4}$*d.*, £6. 10*s.* 4$\frac{1}{2}$*d.* (121) £302076. 19*s.* 10*d.* (122) £815. 14*s.* 1*d.* (123) 49 lbs. 4·655 oz. (124) 12 days. (125) 1·02 %. (126) 4$\frac{1}{4}$ sq. yds., 17*s.* (127) ·997916. (128) 6400. (129) £2693. 14*s.* 7$\frac{1}{2}$*d.*, £811. 1*s.* 5*d.* (130) £2. 16*s.* 0$\frac{1}{2}$*d.* (131) *a.* 5·899. *b.* 128875·773. *c.* 340800·393.* (132) 60996·9. (133) 2$\frac{34}{343}$, ·063. (134) 18*s.*, 7·563 %. (135) £1250000, £128048. 15*s.* 7$\frac{1}{4}$*d.* (136) 4·92, 55·9, 27·5028, $\frac{296}{2795}$.

* This answer erroneously assumes that the decimal 3·1415927... terminates with the 7, disregarding the...which indicate that the figures to follow are omitted. Consequently our product is in this case only reliable to one place.

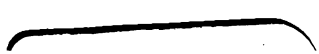
(137) £4166. 13*s.* 4*d.* (138) 86. (139) 196·76127667, 38·72983346, 12·24744871, 2·64575131, ·83666002, ·26457513, 7, 2·21359436, ·7, ·70352626, ·583̇. (140) $91\frac{19}{27}$ gr., $82\frac{8}{15}$ deg. (141) £97. 5*s.* $11\frac{1}{2}$*d.*, £118. 18*s.* $4\frac{1}{2}$*d.* (142) £12. 1*s.* 6*d.*, £8. 1*s.*, £6. 0*s.* 9*d.* (143) The second, 1·069 %. (144) £1. 15*s.* 5*d.* per dozen loss. (145) ·75. (146) £25. (147) 140 c. ft. $729\frac{13}{48}$ in. (148) 3·129 %. (149) $\frac{1}{2}$, $\frac{3}{7}$, $\frac{13}{30}$, $\frac{68}{157}$; $\frac{1}{14}$, $\frac{1}{210}$, $\frac{1}{4710}$. (150) £124. 11*s.* 8*d.* (151) £89. 12*s.* (152) ·00000001872. (153) £68. 19*s.* $1\frac{3}{4}$*d.* (154) £74. 2*s.* 6*d.* (155) £2. 19*s.* 10*d.* (156) 22, 7, 12 gals. (157) 18·41 times. (158) 25920 years. (159) 20 min. 9·956 secs. (160) £232. 0*s.* $7\frac{1}{4}$*d.* (161) £23200000, 7·887 %, the 5 %. (162) 3100 men.* (163) $6\frac{2}{3}$ % profit. (164) £1860, 2 years. (165) ·99726. (166) £3. 10*s.* (167) 179 persons. (168) £989. 12*s.* 6*d.* (169) 101 tons, 5 cwt. 2 qrs. 19 lbs. (170) 75. (171) A. (172) 120000. (173) £75. (174) 12·8375. (175) 3 non., 4 non., 4 non., 10 non., 5 non., 6 rec., 3 non. + 6 rec., 6 rec., 6 rec., 6 rec., 1 non. + 6 rec., 78 rec., 30 rec., 198 rec., 1 non. + 6 rec. (176) 687500. (177) 6 games, £2. 16*s.* (178) $\frac{1}{4}$, $\frac{5}{21}$, $\frac{31}{130}$, $\frac{222}{931}$; $\frac{1}{84}$, $\frac{1}{2730}$, $\frac{1}{121030}$. (179) 8 %. (180) 237500 fr. (181) 28·78 %. (182) £2. 8*s.* $1\frac{3}{4}$*d.* (183) 3·297 ft. (184) 101. (185) 1·394. (186) 2·04 knots. (187) £12. 5*s.* $10\frac{1}{2}$*d.*, £2. 5*s.* 10*d.* (188) £11. 2*s.* 11*d.*, £3. 8*s.* $9\frac{1}{2}$*d.* (189) 69·5 yards. (190) £1417. 10*s.* (191) 3*s.* 3*d.* (192) £8000, £7530. (193) $9866\frac{2}{3}$ c. ft. (194) 3 ft. (195) See Ch. VII. § 8. (196) 23·4 min. (197) £6. 18*s.* $7\frac{1}{4}$*d.* (198) 1, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{5}$, $\frac{8}{13}$. (199) 655 : 528. (200) 16000. (201) £741286506. 7*s.* $8\frac{1}{2}$*d.* (202) 24700·44 fr. (203) £533. 6*s.* 1*d.* (204) 153 c. yds. (205) 1·71 ft. (206) 10·8 oz. (207) 2 dearer, 1 cheaper. (208) ·6*ee*51̇, ·7̇, ·700*t*5̇, ·70052. (209) 4 shares, £235. (210) $\frac{2}{11}$. (211) 39·3708 in. (212) See Ch. VI. § 19. (213) £40. 13*s.* $10\frac{1}{2}$*d.* (214) I gain 3*s.* 9*d.* (215) ·011̇, ·1̇0̇, ·12̇, ·1̇4̇, ·213̇, ·2̇4̇, ·3̇, ·3̇, ·375̇, ·46̇; 110100011·00̇1̇, 120112·0̇10212̇, 12203·02̇1̇, 3134·0̇32412̇, 1535·0̇5̇, 1136·1̇, 643·1̇, 515·125̇, 419·142857̇, 2*te*·186*t*35̇. (216) The difference has no factors but 2 and 5, which cannot measure odd numbers that are not multiples of 5. (217) $19\frac{1}{4}$ women. (218) 300 boys. (219) *a.* ·28̇. *b.* ·165̇0̇. *c.* ·1013223201̇.

$$\cfrac{1}{4+\cfrac{1}{5+\cfrac{1}{6+\cfrac{1}{7}}}}$$

* See Errata.

(220) 160 oz. = £6203. (221) 2 tons, 17 cwt. 3 qrs. 10·059 lbs. (222) 34·842 ft. (223) In 6 days altogether. (224) £2. 10*s.* (225) £3. 3*s.* 3*d.* (226) 18·33 seconds. (227) 6·194%. (228) £4. 15*s.* 2*d.* (229) $24\frac{3}{4}$. (230) £3339. 15*s.* (231) 300 times. (232) 11224868534538. (233) 8 months. (234) 129 days, or 4·24 months. (235) $29\frac{1}{5}$ days. (236) £1678. 12*s.* 9*d.* (237) *a.* The sum is increased by twice that quantity. *b.* The difference is unaltered. (238) *a.* The sum is unaltered. *b.* The difference is increased or diminished by twice the quantity according as the greater of the two is increased or diminished. (239) *a.* The product is multiplied by the square of the number. *b.* The quotient is unaltered. (240) *a.* The remainder is diminished by that number × the quotient. *b.* The remainder is increased by that number. (241) The remainder is (*a*) multiplied, (*b*) divided by that number. (242) A proper fraction is increased; an improper fraction diminished. (243) The ratio is multiplied by the square of the number. (244) The square is increased by the square of the new number, and twice the product of the two numbers. (245) Twice the product of the two numbers. (246) (*a*) The sum (*b*) the difference is multiplied by the number. (247) Each is multiplied by that number. (248) It must be halved. (249) *a.* 1, $\frac{1000000}{1000001}$, 1, $\frac{6000000}{6000006}$. (250) $I = \frac{p \times r \times t}{100} = \frac{p \times 3 \times d}{100 \times 365}$, where d is the number of days, $= \frac{p \times 2 \times d \times 240 \times 3'}{100 \times 730}$ (in pence) $= \frac{p \times 2 \times d}{100} \times \frac{72}{73} = \frac{p \times 2 \times d}{100} \times (1 - \frac{1}{73})$ $= \frac{p \times 2 \times d}{100} \times (1 - \frac{1}{70})$ nearly. Maximum error, $(\frac{1}{70} - \frac{1}{73}) \times \frac{p \times 730}{100} = \frac{3}{700} \times p = 3d.$ on every £700 = 1*s.* on every £2800.

ERRATUM.

Chap. XIV. (42), for "pounds sterling at 25·22 fr.," read "at 25·22 fr. per pound sterling."

Part II., Answer to Ex. LI. (41), read "30 days."